Advancing Resource Management in Harvard University's Facility Maintenance Operations (Cambridge, MA)

1. OVERVIEW

Harvard University is the oldest institution of higher learning in the United States (founded 1636), with an endowment of $19.2 billion (FY 2000) and a student population of 18,598 full-time equivalent (FTE) students enrolled in the undergraduate college and 10 graduate and professional schools. Harvard employs 15,101 FTE faculty and staff. The majority of the Harvard campus and physical plant is situated in Cambridge, Massachusetts, with the Business and Medical School located in Allston and Boston.

Facilities Maintenance Operations (FMO), a department of the University Operations Services (UOS), is responsible for most solid waste management activities on campus, providing solid waste/recycling services to 70% (~130) of Harvard buildings. Most of the remainder are managed by Harvard Real Estate, which administers separate waste and recycling contracts for their facilities.

FMO employs approximately 450 full-time equivalent employees (FTEs), and provides nearly $40 million in services annually through its four primary business lines: building maintenance and operation, custodial services, landscape care, and solid waste/recycling. All FMO functions are provided through fees for services to University customers. Its four service units are organized to operate as contract businesses, negotiating arrangements for services directly with customers who occupy a wide variety of facility types, ranging from laboratory and teaching environments to libraries, museums and residential buildings. FMO services more than 12 million square feet of building space and over 150 acres of University-owned property.

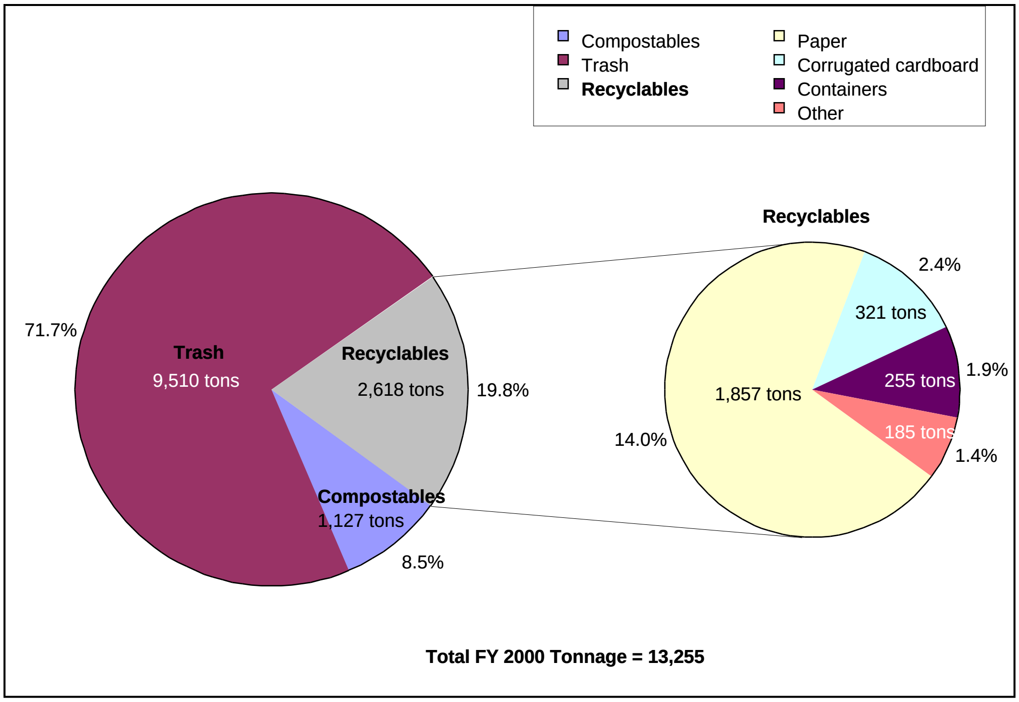
2. BASELINE SOLID WASTE AND RECYCLING SERVICES AND LEVELS

FMO's trash and recycling services rely on a combination of FMO resources and external hauling, recycling, and disposal contractors. FMO resources are used to collect and consolidate refuse and recyclables from approximately 25% of buildings serviced due to noise ordinances and other by-laws that restrict movement of large waste vehicles and the placement of dumpsters. FMO owns a small garbage packer and a dedicated paper packer both of which it uses to collect waste from restricted facilities each morning. FMO vehicles then "dock" with trash and recycling contractors' vehicles at a suitable location, and transfer their loads.

Contractors also collect waste, recyclables, and compost from the service entrance or trash room of individual buildings, or from designated pick-up areas where materials have been consolidated. These services also include provision and maintenance of containers (from 2 to 30 cubic yard capacity) and compactors for loose material, additional containers and service for demolition debris and thrice yearly major clean-ups (Spring, Fall, Commencement). While the majority of material collected consists of trash in bags, there is also some trash in boxes, and bulk waste such as carpets, furniture, and electronics. FMO also provides barrels and other marked receptacles for recyclable paper collection, which the responsible contractor services.

During fiscal year 2000, nearly 13,255 tons of material was managed on behalf of university clients, as shown in Figure 1.[1] The largest portion (72%) of materials was managed as trash, while 8.5% and 20% was managed as compostables and recyclables, respectively. Of the recyclables, 71% (1,857 tons) consisted of paper, while 29% (761 tons) consisted of containers (metal and plastic), corrugated cardboard, and "other" recyclables. Much of the corrugated cardboard and paper generation stems from 13 geographically dispersed kitchens.

Figure 1: Solid Waste Materials Managed by Harvard University in FY 2000



FMO has conducted waste audits every Fall since 1999. In the audits, 50-80 bags are taken from various locations and their contents weighed to derive the composition of the waste stream. The composition of the 72% (9,510 tons) of waste as deduced from the November 2000 waste audit is shown in Figure 2. These data show that 85% of current waste stream consists of readily recyclable/compostable material. Thus, while Harvard has achieved a respectable 28% diversion rate, there are opportunities to increase performance by capturing the remaining recyclable and compostable materials in the waste stream (Figure 3).

FMO's success with recycling and recovery thus far is due in large part to its acting in some capacities as an RM service provider by overseeing recycling and garbage service, assessing garbage and recycling service needs on a continual basis, identifying options for enhancing recovery, and evaluating recycling benefits in terms of disposal cost avoidance and commodity revenue. Careful data management, waste stream analysis, and baseline information has facilitated these efforts.

[1] Note that this includes FMO managed materials as well as those managed by other contractors serving university clients (e.g., Harvard Real Estate Contractor, Business School). FMO managed over 70% (9563 tons) of this amount, and achieved a 32% recycle rate on its accounts.

Figure 2: Composition of Harvard Trash, FY 2000

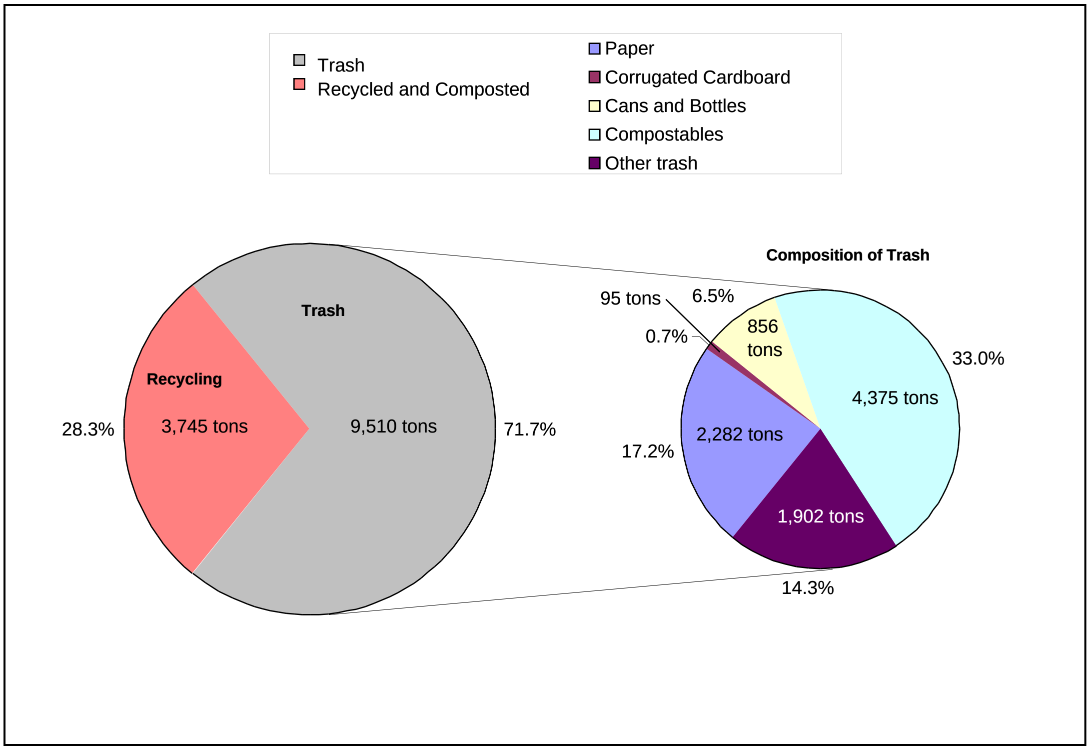
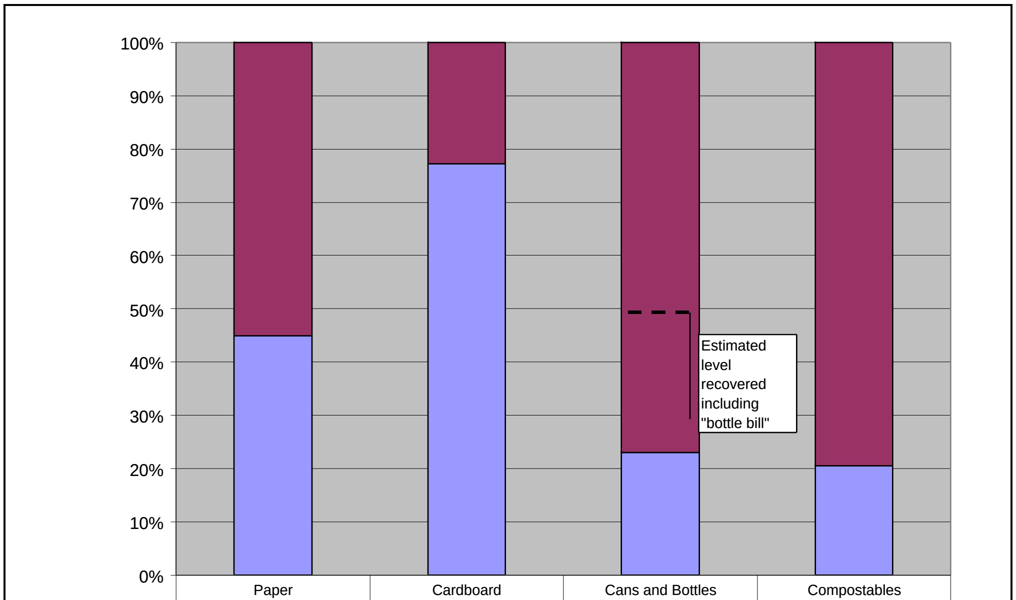


Figure 3: Materials Recycled versus Materials in Trash for Harvard, FY 2000



	Paper	Cardboard	Cans and Bottles	Compostables
Tons in Trash	2,282	95	856	4,375
Tons Recovered	1,857	321	255	1,127

3. BASELINE CONTRACTS, COMPENSATION, AND INCENTIVES

FMO has several contracts for waste hauling/disposal, and collection/hauling/processing of client waste, compost, and recyclables (see Table 1). A three-year waste hauling and disposal contract was awarded to the waste contractor in 1997, and was recently extended through 2002. This contract covers waste container and compactor rental and maintenance, temporary roll-off rental for construction and year-end clear-out debris, hauling, and disposal. Disposal costs are compensated on a $75 per ton tip fee. In FY2000, FMO paid $342,000 for hauling and container service, and $483,900 in tipping fees in FY2000 on 6,452 tons disposed, for a total contract cost of $825,900.

FMO has separate agreements for the paper and corrugated cardboard recycling, container recycling, and compost services. Each of these contracts expires at the same time as the waste contract (June 2002). For paper and corrugated cardboard recycling services, FMO has separate collection and processing agreements. FMO pays an hourly service fee of $90/hour to its paper and cardboard recycling collection contractor, which totalled $13,126 for 282 tons of paper ($47/ton) in FY2000. FMO staff collects the remainder of the paper and cardboard. Paper and cardboard is transported to an area recycling processor whose compensation is determined based on the difference between a $30/ton processing fee and the New York market "yellow sheet" commodity price for the relevant material for the invoiced month. Thus, when commodity markets are strong, FMO receives net revenue for the paper stream, and when they are weak, FMO pays a net processing cost. For instance, in December 2000, FMO received $20 per ton for delivered paper and corrugated ("yellow sheet" value of $50/ton). Currently, FMO is paying $5 per ton ("yellow sheet" value of $25/ton) for delivered paper and corrugated. Net costs for the paper processing contract were $36,394 ($27/ton) in FY2000.

Table 1: Summary of FMO Waste/Recycling Rate Structure and Contract Costs

Scope	Rate/Credit Structure	FY 2000 Cost
Waste hauling and disposal	Container rental and hauling flat fee, $75/ton tipping fee	$825,900
Paper/OCC recycling collection	$90/hour	$13,126
Paper/OCC processing	$30/ton fee - NY "yellow sheet" commodity price for relevant material invoiced month*	$36,394
Container processing	$25/ton	$3,875
Compostables	$160/month container rental; $60/ton processing	$31,430
Lab Recyclables	$4.32/bag	$28,260
Total		**$938,985**

* This pricing structure was introduced late in FY2000.

For container recycling service, FMO labor and resources are used for collection and delivery of containers to the same processing contractor that receives Harvard's paper and corrugated recyclables. As part of a separate contractual arrangement with the processor, FMO presently pays $25/ton of containers delivered, which totalled approximately $3,875 in processing fees in

FY 2000. FMO also has a contract for a lab plastic recycling program, which cost $28,260 in FY2000 for an estimated 13 tons managed, or $2,174 per ton.

For management of its organic waste stream, which is generated primarily by Harvard kitchens and dining halls, FMO has a contract with a local organization that uses the organic material in agricultural applications. FMO pays $160/month ($1,920/year) for barrel rental, and $65/ton for hauling/processing under this contract. The container rental and 454 tons managed under this contract in FY2000 represent a net cost of $31,430 ($69/ton).

In addition to the contractual costs described above, FMO incurs expenses for contract and labor management and material collection and consolidation (i.e., trash and recyclables) prior to contractor pick-up. This totalled over $482,000 in FY 2000, or 51% of the total waste and recycling contractor charges of $939,000, and is thus a significant cost element. Of this amount, trash service overhead (management and supervisors) and hand pick-up by FMO staff totalled $213,000 (26% of trash contract charges), while recycling overhead and FMO collection amounted to $268,000 (28% of all recycling contract charges). It should be noted that FMO operates in a unique environment that has a direct bearing on these FMO incurred expenses. The Harvard campus layout (dating from the 17th century) and certain aesthetic and noise ordinances dictate against the use of large, mechanized collection and hauling technology. By necessity rather than by choice, FMO must employ a higher degree of manual or small-scale collection activity than in other comparable academic or industrial settings. Despite these caveats, there may be potential to further optimize this collection service.

While the contracts described above provide an opportunity for FMO to realize cost savings in the form of avoided disposal costs and recycling revenues on paper and corrugated cardboard, they do not maximize and align cost-effective incentives for collaboration among all contracted parties to increase diversion/recycling rates and collection cost efficiency. As the next section will discuss, structural adjustments to contracts could provide price signals to contractors (in the form of performance bonuses and liquidated damages) to increase recycling rates without significantly altering overall contract costs.

4. OPPORTUNITIES FOR COST SAVINGS AND ENHANCED RECYCLING SERVICES

Because its clients (i.e., Harvard buildings) are not obligated to use FMO, FMO must provide services that are competitive with external providers. The result of this competitive environment is very tight accountability for service quality and value. Restructuring certain contract elements to be consistent with RM could help FMO enhance its competitiveness as a value-added, integrated waste management service provider. Relatively simple actions, such as constraining disposal compensation and providing performance bonuses for cost-effective resource efficiency innovations could serve as a point of departure for further resource efficiency improvements through waste minimization (source reduction) and efficient material handling, recycling, recovery, and disposal.

For example, FMO might consider financing recycling performance bonuses with garbage hauling and disposal fee savings, and a portion or all benefits from recycled commodity revenue, with loss assurance in the form of shared costs when commodity markets are weak. To demonstrate how this might work, Table 2 presents a number of scenarios providing progressive improvements from the Harvard baseline. Note that this is based on Harvard-wide figures for 2000 under the assumption that capturing the remaining 25-30% of Harvard business it does not handle is a business opportunity for FMO. Cost projections, as noted, are based on FMO contract costs.

Because recycling revenues are variable, conservative assumptions are made concerning the values for each commodity used in the assessment, although in strong markets, these may add considerably to the financial draw of providing resource efficiency improvements in an environment characterized by RM-like compensation structures. The data shows that avoided disposal fees represent the largest portion of the cost savings from increased diversion. Together, avoided disposal costs and recycling revenues exceed the added external expense that could be expected to result from higher levels of recycling service (Table 2). For instance, in the ambitious Scenario 3 cost savings are estimated at $271,973 or 29% of current contract costs. However, even in the more modest Scenario 2, the cost savings represent 18% of overall contract spend in FY2000 (Table 3). These figures represent “gain-sharing potential”, or the amount that could be divided between FMO and the contractor. In some cases, organizations choose to forfeit all savings to the contractor to maximize the contractor’s inducements to increase diversion. When FMO collection labor and management overhead are factored into recycling costs for each of the scenarios (Table 4), the same trend of increased savings is observed, although in this case a diminishing net cost of service remains. These savings translate into decreased prices (“bag charges”) for customers as a result of decreasing FMO cost recovery requirements, thereby increasing FMO’s competitiveness.

Additional savings could result from material handling, collection, and consolidation efficiencies. For example, FMO paid $213,429 (21% of total trash service expense) in FY 2000 for hand trash consolidation and management overhead, and $268,638 (70% of total recycling service expense) for recycling consolidation and overhead. While the extent to which an RM contractor could provide solutions to minimize these costs and optimize service would need further examination, these costs present another facet representing significant potential savings. For example, aspects of the current FMO oversight responsibilities could fall to the RM contractor. It should be noted that achieving these savings might be complicated by restrictions on vehicle movement and other logistical constraints related to the Harvard campus. This assessment also excludes expected cost savings in waste hauling and container services that would result from diminished capacity required to serve FMO customers.

Table 2: Potential FMO Avoided Disposal Costs and Recycled Commodity Revenues based on FY 2000 Generation Levels/Disposal Costs

Material (1)	Scenario Name (1)	% of Material in Waste Stream (2)	Capture Rate of Material	Tonnage of Material Recovered	Avoided Disposal Fee (3)	Recycling/ Material Recovery Revenues (4)	Recycling Costs (5)	Total Savings
Paper	Current	24%	45%	1,857	$148,560	$6,091	$73,606	$81,044
	Scenario 1	24%	50%	2,070	$165,560	$6,788	$82,029	$90,319
	Scenario 2	24%	70%	2,897	$231,784	$9,503	$114,841	$126,446
	Scenario 3	24%	90%	3,725	$298,008	$12,218	$147,653	$162,573
OCC	Current	1%	77%	321	$25,680	$1,053	$12,724	$14,009
	Scenario 1	1%	80%	333	$26,624	$1,092	$13,191	$14,524
	Scenario 2	1%	85%	354	$28,288	$1,160	$14,016	$15,432
	Scenario 3	1%	90%	374	$29,952	$1,228	$14,840	$16,340
Cans and Bottles	Current	9%	23%	255	$20,400	NA	$6,375	$14,025
	Scenario 1	9%	35%	389	$31,108	NA	$9,721	$21,387
	Scenario 2	9%	55%	611	$48,884	NA	$15,276	$33,608
	Scenario 3	9%	75%	833	$66,660	NA	$20,831	$45,829
Compostables	Current	46%	20%	1,127	$90,160	NA	$31,430	$58,730
	Scenario 1	46%	35%	1,926	$154,056	NA	$53,704	$100,352
	Scenario 2	46%	55%	3,026	$242,088	NA	$84,392	$157,696
	Scenario 3	46%	75%	4,127	$330,120	NA	$115,081	$215,039

(1) Scenarios were developed based on capture rates for different materials within the different types of organizations, thus capture rates vary by organization. Incremental gains for a material with a relatively high capture rate in one organization would be more modest than for organizations with lower capture rates of the same material. Readily available sector based waste composition data was used to estimate the capture rates. When actual waste composition data was not available California Integrated Waste Management Board standards were used. Scenarios were calculated showing incremental gains for each chosen material. Materials such as paper, cardboard, glass, plastics and organics with readily available secondary markets were chosen.
(2) From FY2000 waste audits.
(3) Estimated on FMO charges of $80/ton for 2001.
(4) For paper and OCC, the average revenue per ton from FY2000 of $3.28 was used. For Cans and Bottles, no value was assigned to these materials due to higher variable markets.
(5) These are linear projections from baseline costs based on tonnage increases, holding FMO vehicle and management costs constant, while treating FMO labor and overall contract costs as variable.

Table 3: Summary of Potential FMO Contract Cost Savings

	Tonnage Material Recovered	Resulting Recycle Rate	Avoided Disposal Fee	Recycling / Material Recovery Revenues	Total Revenue/ Savings	Recycling Costs	Savings	Savings from Baseline	Savings as % of affected Service Base
Current	3,560 (1)	27%	$284,800	$7,144	$291,944	$124,135	$167,809	NA	0%
Scenario 1	4,717	36%	$377,348	$7,880	$385,228	$158,646	$226,581	$58,773	6%
Scenario 2	6,888	52%	$551,044	$10,663	$561,707	$228,526	$333,181	$165,373	18%
Scenario 3	9,059	68%	$724,740	$13,446	$738,186	$298,405	$439,781	$271,973	29%

(1) Excludes 185 tons of "other" recyclables.

Table 4: Summary of Potential FMO Total Cost Savings (With FMO Overhead)

	Tonnage Material Recovered	% Increase Diversion from Baseline	Avoided Disposal Fee	Recycling/ Material Recovery Revenues	Total Revenues/ Savings	Recycling Costs	Savings/ (Net Cost)	Savings from Baseline	Savings as % of affected Service Base
Current	3,560	NA	$284,800	$7,144	$291,944	$455,199	($163,256)	$0	0%
Scenario 1	4,717	32%	$377,348	$7,880	$385,228	$512,360	($127,132)	$36,123	4%
Scenario 2	6,888	93%	$551,044	$10,663	$561,707	$658,683	($96,976)	$66,280	7%
Scenario 3	9,059	154%	$724,740	$13,446	$738,186	$805,005	($66,819)	$96,437	10%

5. REALIZING COST EFFECTIVE RECYCLING AND REDUCTION POTENTIAL WITH RM CONTRACTING

Six standard practices for preparing and implementing an RM contract are identified in Table 5. These stem from findings during the course of this and prior projects regarding: (a) the availability and use of information on current contract pricing structure, payments, and baseline waste management/recycling levels; (b) pre-bid information-gathering tactics, and (c) the nature of the incentives created by current contract pricing structures.

These practices are essential elements of any RM contract because they align customer-supplier incentives for resource efficiency by establishing a compensation mechanism based on supplier performance and continuous improvement. Furthermore, the practices provide an information-rich environment in which to evaluate resource efficiency opportunities. Although the practices are somewhat interrelated, the first practice provides the foundation for implementing Practices 2-6.

Table 5: Summary of Standard RM Practices

RM PRACTICE	DESCRIPTION	PRESENT
1. Establish Baseline Cost, Performance and Service Levels	♦ Define scope and service levels ♦ Identify existing contract and compensation methods ♦ Establish cost and performance benchmarks and goals	X
2. Seek Strategic Input from Contractors	♦ Convene pre-bid meetings with contractors to articulate goals and address questions ♦ Allow or require bidders to submit operations plans for achieving specified improvements in existing operations	
3. Align Waste and Resource Efficiency Services	♦ Coordinate, integrate, and formalize all contracts and services included in the baseline scope identified in Practice 1 ♦ Ensure that contractor has access to "internal" stakeholders that influence waste management and generation	X
4. Establish Transparent Pricing for Services	♦ Delineate pricing information for specific services such as container maintenance, container rental, hauling, disposal, etc. ♦ Allow variable price savings, such as "avoided hauling and disposal" to flow back to generator and/or be used as means for financing performance bonuses.	X
5. Cap Compensation for Garbage Service	♦ Constrain waste hauling/disposal service compensation by capping or changing to "on-call service." ♦ De-couple contractor profitability from waste generation and/or service levels. ♦ Based initially on reasonable estimates of current hauling and disposal service and costs as per practice 1.	
6. Provide Direct Financial Incentives for Resource Efficiency	♦ Establish compensation that allows contractor to realize financial benefits for service improvements and innovations. ♦ Assess liquidated damages for failing to achieve minimum performance benchmarks or standards.	

An assessment was conducted to determine the extent to which RM practices were part of existing contracting at FMO. The results of this assessment suggest that there is additional potential for RM contracting practices to leverage recycling improvements as a cost neutral (or even cost saving) proposition to FMO, as discussed in Section 4. Those practices identified, as present in Table 4, are RM practices that are the most mature or best established in FMO's current contracts and practices.

1. *Establish Baseline Cost, Performance, and Service Levels.* The cost and service baseline is well documented by FMO staff. FMO's biannual waste audits provide indications of diversion performance and improvement potential. Its baseline service levels and pricing structure determined by fully-burdened bag charges are well established, as required by its somewhat unique situation requiring accountability to its clients. This information enabled the assessment of potential savings from increased diversion that could be leveraged for contractor performance bonuses under an RM contract.

2. *Seek strategic input from prospective contractors.* FMO would benefit from improved involvement with prospective contractors in the bid phase and throughout the term of their contracts. While contract bid requests have historically stated an explicit preference for recovery over solid waste disposal, bidders often have little opportunity to provide input on service requirements due to somewhat restrictive work specifications. In other words, it

would identify exactly how something is done rather than the desired result. Providing this information and soliciting input in the pre-bid period would allow FMO the flexibility to explore the extent to which prospective contractors can propose alternative solutions and pricing structures in an "open"[2] bid and identify and provide cost-effective improvements to existing services. While this approach is likely to produce a wider array of service options from which to choose, it may require a heavier initial investment in FMO staff time to interact with prospective bidders and evaluate contractor proposals.

3. *Align garbage, reduction and recycling services.* RM seeks to coordinate services so that waste management and recycling elements of an RM program are mutually reinforcing in support of resource efficiency goals. Key preconditions for coordination are fee structures that allow the generator to realize across the board recycling revenues and cost savings from avoided hauling/disposal fees. Also, this ensures that all services are leveraged to work towards the same organizational resource efficiency goals, while reducing management costs associated with administering numerous uncoordinated contracts and agreements. As the "gatekeeper" of Harvard's solid waste and recycling service contracts, FMO has effectively coordinated garbage, reduction and recycling services and has instituted a fee system that allows generators (i.e., its clients) to realize cost savings for enhanced recycling. The question that should be asked is whether all or part of this same function can be performed by a contractor more efficiently, allowing FMO to divert those resources normally spent in waste/recycling contract coordination to other business areas.

4. *Establish transparent pricing for services.* FMO has benefited from having suppliers "unbundle" pricing structures to specify hauling on a fixed basis, and disposal on a variable basis (i.e., $ per ton tipped). This allows FMO to more easily assess and negotiate savings on the volume of materials disposed in future contracts. Furthermore, negotiating rates of return on recycled materials such as containers or compost would be advantageous, as FMO does not receive revenues from all recycled materials. These dual savings could be used to finance performance bonuses and/or assess reasonable liquidated damages as described in practice 6. However, as it currently stands, the FMO waste contractor has an incentive to provide ever increasing waste service, despite transparent pricing. This undermines recycling efforts. The two final practices seek to de-couple contractor profitability from increasing waste service levels.

5. *Cap Compensation for Disposal Service.* FMO could limit the extent to which their existing hauling contract provides a profit incentive for ever-increasing garbage service levels. Using its baseline hauling cost information, FMO could establish a cap on what it is willing to pay on hauling/disposal service that decreases gradually over time based on reasonable estimates of current and expected service. While the contractor should receive fair compensation for these services, over time elements of the service are "phased out" and replaced with alternative compensation schemes that reward resource efficiency, as per practice 6. In this structure, required waste hauling and disposal is accomplished on a pure cost recovery basis, while recycling and other forms of resource efficiency and services drive contractors' profitability.

[2] An open specification includes performance-based objectives in place of limiting requirements to location, service level, number of containers and pick-ups exclusively, leaving it open to bidders how they propose to satisfy performance objectives.

6. *Provide Direct Financial Incentives for Resource Efficiency.* FMO could provide performance bonuses for exceeding a mutually agreed upon baseline recycling/resource efficiency performance benchmark. Savings on avoided landfill disposal fees and revenues received for recycled commodities (as established in practice 4) could finance such a performance bonus. To help ensure modest gains in recycling, minimum performance levels could be increased over each year of the contract period. For example, increasing the minimum by 5% over the baseline recycling for a 3-year contract period would bring about a 15% increase in recycling by the end of the contract period. Compensation could be structured such that the contractor receives performance bonuses as long as the minimum annual performance level is achieved. Thus, if in year 3 of the contract the minimum recycling level was 5,000 tons and the contractor collected 6,500 tons of recyclables, the contractor would receive a performance bonus on 1,500 tons of recyclables. On the other hand, if the contractor collected 4,000 tons in year 3, it would pay liquidated damages on 1,000 tons of materials. Establishing minimum tonnage requirements and associated performance bonuses may give contractors the financial incentive they need to assume a more active role in organizational recycling efforts that extends beyond hauling and material processing.